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# THE TRANSITION BETWEEN ERAS

## *The Long-Wave Cycle*

We are in a time of transition between economic eras—a midpoint in the "Kondratieff cycle." Now is the time to examine our alternatives and try to plan our economic future, says author Scott Erickson.

Modern society is in a time of transition. Serious disturbances in economic and social life as well as the rapid development of technology over the last few years have convinced many that fundamental alterations are now taking place.

Of the many changes that characterize this transition, some of the most interesting have appeared in the behavior of the economy. The steady growth and development that followed World War II became uneven by the early 1970s. The ebb and flow of growth and other current characteristics of economic behavior escape convincing explanation by conventional economics.

These changes, however, are roughly consistent with the long-wave or Kondratieff cycle in the economy. The long wave is a 45- to 60-year cycle of growth and decline in economic development. It is driven by the establishment, growth, and then overexpansion of an interrelated complex of technologies and industrial processes that eventually reach diminishing returns.

In the 1920s, Nikolai Kondratieff, a Russian economist, reported statistical evidence of long waves of prosperity, recession, depression, and recovery in the economies of France, Germany, Britain, and the United States. The Kondratieff cycle is the longest of several cycles now used to explain business and economic behavior and provide insight into the transitions industrial so-

cieties pass through between economic eras. It reflects an ebb and flow in economic development that has now passed through nearly four complete cycles since the beginning of the Industrial Revolution in the late eighteenth century.

Dates for the long wave have been calculated by several economic historians. They differ in detail but tell a similar story. Kondratieff himself suggested the dates for the upward and downward curves of the first three long waves shown in the chart below.

In the 1970s, Jacob Van Duijn, a Dutch economist, proposed a revision of the stages of the long wave based on his own review of the available evidence (see chart on page 41).

Some of the dates are slightly different between Kondratieff's and Van Duijn's calculations, since they investigated different data from different countries. What is remarkable is how similar the conclusions are. Since the beginning of

the industrial era, the world economy has seen four fundamental waves of development, each one identified with a particular set of technologies and commercial enterprises.

### Studying the Long Wave

The idea of a long wave in economic development was well known in the West by the mid-1930s, but the period of unbroken growth in the 1950s and 1960s—the upswing portion of the fourth long wave—pushed the long-wave thesis into the background until it was rediscovered during the economic turmoil of the 1970s.

Discussion of the long wave has recently been widespread, as exemplified by the publication of a new translation of Kondratieff's *The Long Wave Cycle* in 1984 and MIT professor Jay Forrester's testimony before the Joint Economic Committee of the U.S. Congress in June 1984.

Kondratieff's Dates		
	Upward	Downward
1st Wave	1785-95 to 1810-17	1810-17 to 1844-51
2nd Wave	1844-51 to 1870-75	1870-75 to 1890-96
3rd Wave	1890-96 to 1914-20	1914-20 to (?)

times of prosperity profitable industrial sectors are overbuilt and grow beyond the size needed for long-term equilibrium. Productive capacity is expanded beyond market opportunity, creating large debt. This overexpansion is ended by recession and depression, during which excess productive capacity is physically worn out and financially depreciated until the stage has been cleared for a new era of rebuilding. Decreased profits during this period make it difficult to repay debt, forcing some individuals, businesses, and nations to default.

Several measures display this kind of cyclical behavior. The U.S. producer price index indicates that since the beginning of the Industrial Revolution there has been almost as much deflation as inflation in prices. There have been four price peaks in the last 200 years, with the peaks occurring 45 to 60 years apart.

Other events in industrial society follow this same course. For example, financial panics have occurred primarily during the downward portion of the wave. The first serious financial panic in the United States came in 1819, with others occurring in 1833 and 1837, all in the declining portion of the first wave.

The panic of 1857, during a time of general prosperity, was largely confined to the northern states. Small recessions occurred in the United States after the Civil War, but their significance was diminished in comparison with the severe depression that followed the worldwide financial panic of 1873. Times remained troubled throughout the 1870s and 1880s, with another depression in the United States following the financial panic of 1893.

lowed, with a less severe panic in 1907, and continued until 1920, when there was a worldwide recession. The Great Depression followed in 1929. Starting at the end of the 1930s there was prosperity and price increase until about 1970. Major recessions occurred in 1973, 1979, and 1981.

Financial panics, recessions, and depressions have been concentrated in the downward arc of each of the four long waves since the Industrial Revolution. Related variables, such as bank failures, bankruptcies, unemployment, and real estate crashes, have followed this same pattern.

### Basic Innovation

Long-wave patterns are reflected in many aspects of individual and institutional life, one of the most important of which is the phenomenon of innovation. The frequency of basic innovation tends to follow a peak-and-valley pattern as well.

In the 1970s, Gerhard Mensch, a German economist, calculated and tabulated the number of basic innovations per decade since the mid-eighteenth century. Basic innovations are innovations that had powerful economic consequences and started new industries or transformed existing ones.

Mensch measured the time of the appearance of basic innovations and concluded that basic innovation tends to increase dramatically during the transition from one economic era to another. He argued that hard times between price peaks in the long wave stimulate innovation, which, in turn, pulls the economy out of the depression. Two studies since Mensch have also concluded that peaks in basic innovation in the industrialized world

follow an approximately 50-year cycle.

In examining basic innovations from previous clusters, Mensch points out that basic innovations tend to arise from earlier inventions. There is a gap between an invention and the appearance of a basic innovation. For example, the jet engine became commercially important as a basic innovation around 1941. But it was first demonstrated in a laboratory situation 13 years before, in 1928.

The gap between the appearance of the invention and the appearance of the basic innovation is significant. Invention is going on all the time. But the transformation of inventions into innovations that achieve widespread commercial use seems to occur in clusters that follow the economic cycles. Invention is constant; application is cyclical.

Major expansions of the long wave grow around a highly integrated and mutually supporting combination of technologies. Forrester and his colleague Alan Graham argue that, after such an integrated pattern becomes established, incompatible innovations are rejected as impractical ideas. That is why basic innovations are compressed into a window that opens only every 50 years.

As prices go up, basic innovation goes down; as prices fall, basic innovation goes up. If existing goods command high prices, the motivation to innovate is less. Basic innovation is compressed into the transition between peaks of the long wave.

### Transitions

Dominant forces in the economy and society tend to go through transitions from one long wave to the next. If, in fact, innovations

Van Dulijn's Dates				
	Prosperity	Recession	Depression	Recovery
1st Wave	1783-1803	1815-1826	1826-1837	1837-1847
2nd Wave	1847-1866	1866-1875	1875-1884	1884-1893
3rd Wave	1893-1913	1921-1929	1929-1938	1938-1949
4th Wave	1949-1967	1967-1975	(?)	(?)

**Dominant Forces During Each Long Wave**

	1st Wave	2nd Wave	3rd Wave	4th Wave	5th Wave
<b>Industry</b>	Textiles	Railroads	Automobiles	Electrification	Information
<b>Material</b>	Cotton	Iron	Steel	Plastic	Silicon
<b>Energy</b>	Water	Wood	Coal	Oil	Solar
<b>Communication</b>	Overland	Telegraph	Telephone	Electronic	Space
<b>Nation</b>	France	Great Britain	Germany	United States	United States

help define the coming economic era, there should be significant transitions taking place in the business and commercial sectors.

The leading industry—that which resulted from and attracted the focus of the most dynamic basic innovations—of the first long wave was based on the manufacture of cotton textiles. Building the great railroads was the driving force during the second wave. The leading industries of the third wave were automobiles, especially in the United States, and, to a lesser extent, chemicals, especially in Germany. The fourth wave has been characterized by electrification and the use of electrical products, the single most powerful example of which has been television.

At the time of transition between peaks in the wave, the economy falters because mature industries are in decline. Growth goes on, but only in innovative industries, not in the mature industries. The steel industry and the computer industry in the United States are examples.

Steel was a growth industry in the United States during the third long wave. By the fourth long wave in the 1960s it had passed its peak but still dominated the U.S. and world market after World War II. New steel-making technologies such as the oxygen furnace were available by the 1960s and were widely used—but not in the United States. Now, large American steel corporations are being out-innovated and out-produced around the world—even by mini-mills in the United States. Meanwhile, however, the computer industry, born

in the late 1940s, is a high-growth, innovative industry.

A major challenge faces organizations that dominate an industry as much as did U.S. Steel. The motivation to change is small. But it is the entrepreneurial organizations that usually lead the economy into the next wave. Economist Peter Drucker has pointed out that the long-wave depression is much less severe when there is significant entrepreneurial activity in the economy. This was the case in the United States and Germany in the 1870s and 1880s, and it is true in the United States today.

Entrepreneurial activity in the United States took off in the middle 1970s and has continued to flourish. An entrepreneurial environment has existed during every spurt of innovation between long waves, but not all nations take advantage of it. During the time of transition between economic eras, there are many possibilities. When there is adequate freedom in the economy, every possibility is tried. The ones that work help define the next economic era, as they are the ones that attract investment and grow to become the dominant industries of the next wave.

The materials used by the dominant industries tended to change with each long wave. The dominant material used during each wave changed from cotton to iron to steel to plastics.

The dominant energy source has also changed with transitions in the economy. Those innovations that become successful during times of transition help determine which energy source becomes dominant

during the next long wave. Chief energy sources have undergone a transition from water to wood to coal and now to oil.

Early industrial activity was supported by direct application of water power from rivers and streams during the first wave. By the second wave, wood had become the dominant energy source in most places and was the primary

**Innovations from Previous Surges****Surge in 1870s to 1890s**

Incandescent light (1887, 79)\*  
Electric locomotive (1879, 38)  
Telephone (1881, 21)  
Anesthetics (1883, 52)  
Chemical fertilizers (1885, 45)  
Gasoline motor (1886, 26)  
Aluminum (1887, 60)  
Rayon (1890, 33)  
Antitoxins (1894, 17)  
Refrigeration (1895, 22)

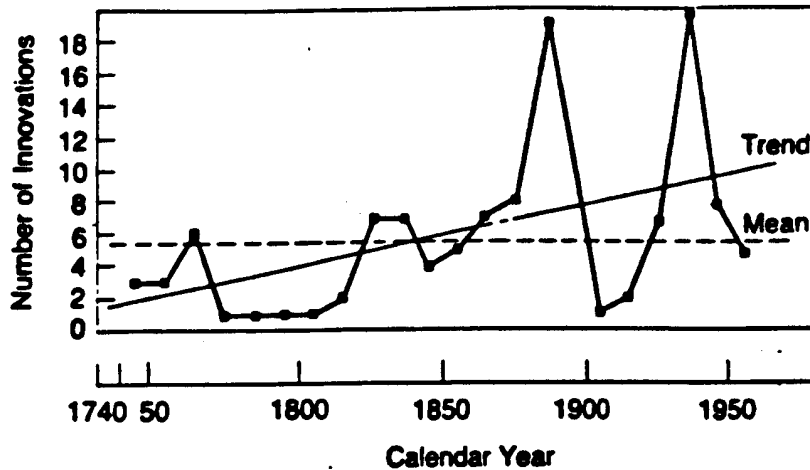
**Surge of 1930s and 1940s**

Power steering (1930, 30)  
Radar (1934, 47)  
Fluorescent light (1934, 82)  
Diesel-electric locomotive (1934, 39)  
Catalytic refining (1935, 20)  
Television (1936, 29)  
Nylon (1938, 11)  
Automatic transmission (1939, 35)  
Penicillin (1941, 19)  
Jet engine (1941, 13)

\*(date of innovation, years from date of invention)

Source: Alan K. Graham, "The Long Wave," *Journal of Business Forecasting*, Vol. 1, No. 5 (Fall 1982), p. 73.

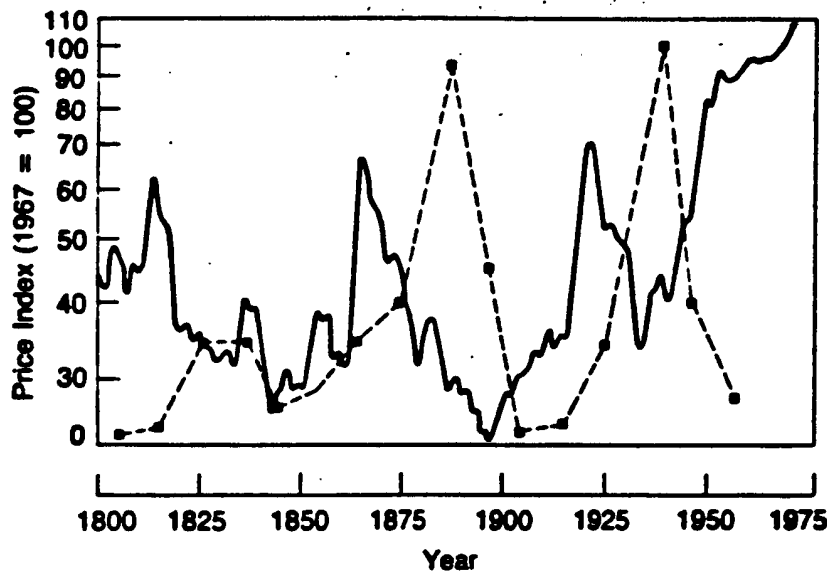
### Frequency of Basic Innovations per Decade



Source: Alan K. Graham, "The Long Wave," *Journal of Business Forecasting*, Vol. 1, No. 5 (Fall 1982), p. 70.

Chart showing the frequency of basic innovations per decade. The frequency of such innovations (the dark line in the chart) follows a pattern of lows and highs much like that of long-wave economic cycles.

### Producers Price Index 1800-1973



In this chart, the frequency of basic innovations per decade (broken line) is superimposed over the producers price index for the United States from 1800 through 1973 (dark line). The inverse relationship between economic lows and times of great innovation is clearly shown.

fuel for generating steam power in railroad locomotives and other steam engines. In the third long wave, coal replaced wood as fuel for steam engines and was used to generate electricity. Oil and natural gas have replaced coal as the pri-

mary fuel during the fourth long wave, and they have become dominant as the fuel for almost all forms of transportation.

During the first long wave, communication traveled over land or water. This was supplemented in

the prices by lower-to-lower signaling systems that used flags to pass some messages more quickly. Communication during the second long wave was dominated by the telegraph. Advances in electrical technology in the 1880s brought the wire-connected telephone and the transcontinental telegraph to the fore during the third long wave. Since the 1930s, electrical amplification has made possible telephone, radio, and television communication worldwide. With each major change, not only has the speed of communication been increased, but also the reach.

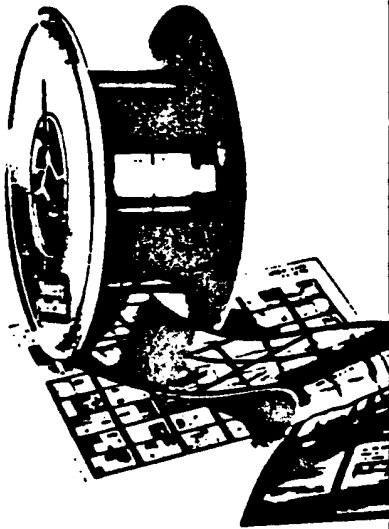
There has also been a dominant national economy and military power in each of these long waves. England was the first nation to industrialize, but during the first wave—at least through the end of the Napoleonic Wars—France had the largest economy and was the leading military power in the world. Between 1815 and 1840, France's place as dominant power was taken by Great Britain. At the end of the second long wave, sometime between 1870 and 1895, a united Germany took center stage as the dominant economic and military power. Between the 1920s and 1945, in the last part of the third long wave, the United States clearly became the dominant economic and military power in the world.

It is at least interesting to note that each of the past economically dominant countries has felt the obligation or the temptation to exercise its military power on the world stage. France failed in its attempt to conquer Europe in the early nineteenth century. Great Britain felt obliged to police the world through the end of the nineteenth century. Germany's quests to subjugate Europe and the world ended in defeat in 1918 and 1945. The United States has felt compelled to police the world in this part of the twentieth century.

### The Fifth Long Wave

There are competing candidates for what will emerge as the dominant industry, material, energy source, communications system, and national economy in the fifth long wave. During this time of

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Transition from one economic era to the next, none of the competing candidates is far enough ahead to be a clear winner. For the next 20 years, there are going to be serious competitors for dominance in each of these categories. But by the end of the transition, one set of forces will emerge that will help shape the fifth long wave.

The leading candidates in each of the categories that will define the fifth long wave are:

- **Industry:** Computers, communications equipment, robotics and cybernetics, DNA-engineered material, somatic modifications, and specialty drugs are potential winners. "Information industry" is probably the best way to describe the set of growing businesses and other commercial activities that is most likely to become the fifth wave's dominant industry, based on advanced electronic technology and encompassing what is already a large part of the work force.

- **Material:** Silicon, composites, ceramics, laminates, and engineered plastics could dominate. The eventual cutting-edge material will be the one most closely supporting the information industry. This will probably be silicon or a silicon substitute such as gallium arsenide.

- **Energy:** The winner here will probably be the energy source that is most compatible with the dominant industry. The various forms of solar energy—renewable, innovative, and applicable to high-technology electronics—may well combine to be the chief energy source of the next wave.

- **Communications:** Space-based satellite systems, fiber optics, microwave systems, or asynchronous computer bulletin board systems could all be used. The next dominant communications system will probably be an electronic space-based satellite system that bypasses the current wire system.

- **National economies:** Leading candidates are the United States, the Soviet Union (currently one-half U.S. GNP), Japan (currently one-third U.S. GNP), West Germany (currently one-fourth U.S. GNP), the European Economic Community (currently about equal to U.S. GNP), China, a united Germany, or a Pacific Rim confederation.

In the fifth long wave, the United States will probably still have the largest national economy. We should remember, however, that national dominance is caused by growth, innovation, and the exercise of power, not by size per se. Countries in dominant positions in the past found difficulty in recognizing when their dominance was threatened.

The United States is far ahead of other national economies at this time, but differentials in growth rate can accumulate over the two-decade transition period that we are now entering. For example, Great Britain fell behind both Germany and the United States at the end of the nineteenth century by having little real growth from 1873 to the early years of the twentieth century. In many ways, the most dynamic area of industrial development today is in the Far East (Japan, South Korea, Taiwan, Hong Kong, and Singapore).

We find ourselves in a time of transition between eras. Like other transitions between previous long waves, this calls for a time of "high thought." The 1980s and 1990s will witness the demise of the fourth long wave and the birth of the fifth long wave. We are now experiencing a surge of innovation in the business and economic sectors. Today's successful innovations will define the character of the next long wave. Our decisions about these innovations—from now through the 1990s, in the public and private sectors—will help to shape the next long wave in the years to come.



### About the Author

Scott W. Erickson is vice president of Infinity Limited, where he works as a consultant on strategic management and the future for U.S. and foreign corporations. His address is 836 Chippewa Avenue, St. Paul, Minnesota 55107.